separation would appear as a dramatic shift in the relative size of the different transitions, shifting the relative sizes of the peaks roughly the same amount for each of the E_{11}, E_{22}, and E_{33} transitions. However, further processing to produce such chirality enriched samples is possible using either the isopycnic method or rate based techniques.

[0113] Alternate scaling of the spectra in FIG. **12** for carbon concentration, either by πr-plasmon region absorbance or by the absorbance in the (1600 to 1800) nm region, does not significantly change the relative increase in the size of the absorption features with length. However, the exact shape of the absorbance below 220 nm as shown may be affected by slight differences in the DOC content of the samples, which is strongly absorbing in this region, with respect to the reference solution. The noise around 1450 nm in the spectra is due to inaccuracy in the subtraction of the strongly absorbing water feature at this wavelength.

[0114] Coupled with the independent measurement of the SWCNT lengths in the various fractions by AFM and DLS, as detailed in FIG. **8**, FIG. **12** strongly demonstrates the length dependent strength of the SWCNT optical transitions that were previously noted in DNA-wrapped SEC sorted SWCNTs.

[0115] FIG. **13** is a photograph of several fractions from different parent solutions showing the solutions that result from the length separations. The solutions labeled CoMoCat type 1 are fractions 6 and 8 from the S-P95-02 grade CoMoCat material separated at 1257 Rad/s previously described. Specifically, FIG. **13** is a photograph of the different color SWCNT solutions that result from length separation of different type distributions of SWCNT starting material. Fractions 6 and 8 are shown for 1257 Rad/s separation of CoMoCat starting materials S-P95-02 and SG-000-0002 (left and center respectively), and fractions 9 and 10 for 1445 Rad/s separation of NASA-JSC soot #338 laser ablation type SWCNTs. Note that solely length and not chirality separation of the black parent solutions has occurred.

[0116] As demonstrated previously, and in the results shown above, SWCNTs can be separated by length through centrifugation in a dense medium. However, the degree and precision of the separation depend upon the chosen parameters for the separation. Several experimental variables are easily modifiable: separation rate, SWCNT concentration, the race layer density, and the bulk temperature of the solution. An increase in the rate of separation, i.e. an increase in the rotor RPM, but maintaining the total applied force generates surprising differences in the achieved separation. FIG. **14**A contains photographs (left to right) of the separation at 785, 1257, 1570, 2513, and 3142 Rad/s, respectively, while FIG. **14**B displays the UV-Vis-NIR projected lengths for the separated fractions. To probe the cause of the change in the separation with rotation speed, several additional investigations were performed at 3142 Rad/s. These included a preparation with approximately 20 mM of additional NaCl in each layer, and preparations with less surfactant (1%) in the layers. No significant change in the **3142** Rad/s separation was identified in either of these investigations.

[0117] Specifically, FIG. **14**A presents photographs, left to right, of SWCNTs separated at 785, 1257, 1570, 2513, and 3142 Rad/s. Note that the furthest distance traveled by the SWCNTs increases with the separation rate, although the total applied force is constant across the experiments. The distribution of the separated SWCNTs within the race layer is also seen to change with the separation rate. Note that the aspect ratio of the images has been uniformly increased slightly to fit the images into the figure. FIG. **14**B presents UV-Vis-NIR projected lengths for the fractions from the different rates of separation. Although the SWCNTs travel the least in the fractions of 785 and 1257 Rad/s, the separation achieved is closest to the theoretical expectation. The plateau region that develops at higher rates of separation is due to mixing of different length SWCNTs.

[0118] Although each of the experiments shown in FIGS. **14** and **16** contained an identical concentration of SWCNTs within the injection layer, for scaling up the separation process, the exact effects of SWCNT concentration on the measured separation could be highly important. Thus, separation experiments were performed with fractional SWCNT concentrations of 4.95×, 1.95×½, and $\frac{1}{5}^{th}$ the typical inoculation. In absolute terms 1× is a concentration of about 0.24 mg/mL within the SWCNT layer in the centrifuge tube, as determined using an estimated extinction coefficient at 775 nm of 26000 mL/mg*cm. The results of the separation, performed at 3142 rad/s for 15 h at 15° C., are shown in FIG. **15**. Surprisingly, the average length of the SWCNTs within the plateau feature increases with additional SWCNT inoculation concentration, actually improving the effected separation. No significant change is observed in the post-separation distribution of lengths with reduction in the initial concentration. A shift towards improved separation is noted with an increase in SWCNT concentration, i.e. for higher mass throughout.

[0119] Specifically, FIG. **15** illustrates the effects of concentration. Changes in the achieved separation were found, however, to occur with an increase in the density of the liquid layers in the centrifuge tube. This is shown in FIG. **16**, in which three tubes are shown where the race layers contained 18, 25, and 30% iodixanol respectively, and the separation was performed at 1257 Rad/s as in the investigation presented in FIGS. **7** and **8**. Interestingly, the changes in the separation with the race layer density mimic the changes that occur due to an increased rotor speed, with the same turnover and plateau features observed in the apparent average length versus distance curves. Reducing the race layer density also changes the separation. This is shown for separation at 3142 Rad/s in FIG. **16**. The reduction in layer density from 18% to 15% actually improves the separation, as can be seen in the projected length. However, with a top layer of 12% iodixanol, separation occurs due to both length and chirality, and the length cannot be projected due to this chirality redistribution. The top fraction of the concentrated band was found to be heavily enriched in the lower density (6,5) chirality.

[0120] Specifically, FIG. **16** presents photographs and apparent SWCNT length versus distance traveled curves for the separation of CoMoCat SWCNTs at 1257 Rad/s (top) and at 3142 Rad/s (bottom) using different density race layers. As expected, at 1257 Rad/s the distance traveled increases with the density of the race layer. However, the separation also becomes less ideal, similar to the effect measured due to an increase in the applied centripetal acceleration. For separation at 3142 Rad/s the separation is more ideal at 15% than at 18%, however, at 12% iodixanol in the race layer, a mixture of chirality and length separation occurs.

[0121] The effect of the bulk temperature during the separation was also explored. Runs at 5° C. and 15° C. were equilibrated to temperature prior to the run within the ultracentrifuge. For the 40° C. separation, the rotor, buckets, and solutions were equilibrated to the proper temperature by immersion in a thermostated bath for several hours prior to